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Sea Turtle Conservation Program, Broward County, FL 2002 Report

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TECHNICAL REPORT DPEP 02-

SEA TURTLE CONSERVATION PROGRAM BROWARD COUNTY, FLORIDA 2002 REPORT

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For the:

BROWARD COUNTY BOARD OF COUNTY COMMISSIONERS
DEPARTMENT OF PLANNING AND ENVIRONMENTAL PROTECTION
BIOLOGICAL RESOURCES DIVISION

TABLE OF CONTENTS

LIST OF TABLES	ii
LIST OF FIGURES	iii
ACKNOWLEDGEMENTS	iv
INTRODUCTION	1
MATERIALS AND METHODS	3
RESULTS	11
DISCUSSION	31
REFERENCES	37
APPENDICES	
I. Summary of Hotline Calls	38
II. Summary of Educational Activities	39
III. Sea Turtle Nest Marker Sign	40
IV. Sea Turtle Summary Report Forms	41

LIST OF TABLES

Table 1: Total loggerhead nests and nesting densities expressed as nests-per-kilometer for 2001. 14

Table 2: Total green sea turtle nests and nesting densities expressed as nests-per-kilometer for 2001. 18

Table 3: Total leatherback nests and nesting densities expressed as nests-per-kilometer for 2001. 18

Table 4: Total nests, false crawls and percent nesting success for three sea turtle species in each of five Broward County beach areas during 2001. 23

Table 5: The total number of nests relocated to Hillsboro Beach, fenced hatcheries, or left *in situ*. 24

Table 6: Total egg counts, released hatchlings and overall hatching successes for *in situ* and relocated nests of all species in 2001. 25

Table 7: Accounting of all categories of hatched and unhatched loggerhead eggs from relocated and *in situ* nests, for each beach during 2001. 29

Table 8: Accounting of all categories of hatched and unhatched green turtle eggs from relocated and *in situ* nests, for each beach during 2001. 30

Table 9: Accounting of all categories of hatched and unhatched leatherback eggs from relocated and *in situ* nests, for each beach during 2001. 30

LIST OF FIGURES

Figure 1: Site location map of Broward County 4-5

Figure 2: The historical sea turtle nesting pattern in Broward County since full surveys began in 1981 11

Figure 3: Historical nesting patterns of loggerheads, greens and leatherbacks in Broward County, 1981-2001. 12

Figure 4: The seasonal pattern of daily loggerhead nest counts in Broward County, 2001. 14

Figure 5: Comparison of the daily loggerhead nesting patterns on the five Broward Co. beaches during 2001. 15

Figure 6: The seasonal patterns of daily green and leatherback nest counts in Broward County, 2001. 16

Figure 7: Comparison of the daily nesting patterns greens and leatherbacks on the Broward County beaches, 2001. 17

Figure 8: Locations of loggerhead, green and leatherback nests in Broward Co., 2001, listed by DEP locator number. 20

Figure 9: The horizontal distribution of average loggerhead, green and leatherback nesting success on each beach segment identified by the DEP survey markers in 2001. 22

Figure 10: Comparison of the seasonal patterns of loggerhead hatching success in relocated and *in situ* nests during 2001. 26

Figure 11: Comparison of the seasonal patterns of green turtle hatching success in relocated and in situ nests during 2002. xx

Figure 12: Comparison of hatching success frequencies for *in situ* and relocated loggerhead nests in 2001. 27

Figure 13: The historical patterns of yearly hatching success in all investigated relocated and *in situ* nests since 1981. 28

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INTRODUCTION

Since 1978, the Broward County Department of Planning and Environmental Protection (DPEP) has provided for the conservation of endangered and threatened sea turtle species within its area of responsibility. Broward County is within the normal nesting areas of three species of sea turtles: the loggerhead sea turtle (*Caretta caretta*), the green sea turtle (*Chelonia mydas*) and the leatherback sea turtle *(Dermochelys coriacea*). The loggerhead is listed as a threatened species, while the green and leatherback are listed as endangered under the U.S. Endangered Species Act, 1973, and Chapter 370, F.S.

Since these statutes strictly forbid any disturbance of sea turtles and their nests, conservation activities involving the relocation of nests from hazardous locations (especially necessary along heavily developed coasts) require permitting by the U.S. Fish and Wildlife Service (USFWS). In Florida, this permit is issued to the Florida Fish and Wildlife Conservation Commission (FWCC), Bureau of Protected Species Management, Tallahassee, Florida. This project was administered by the DPEP and conducted by the Nova Southeastern University Oceanographic Center under Marine Turtle Permit #108, issued to the DPEP by the FWCC.

The DPEP is especially concerned with any environmental effects of intermittent beach nourishment projects on shorelines and the offshore reefs. As part of this concern, the DPEP has maintained the sea turtle conservation program in non-nourishment years to provide a continuous database and for monitoring of completed nourishment projects.

A contract to operate the program is issued based on a review of submitted bids. Nova Southeastern University was awarded the contract to conduct the 2002 program.

In addition to fulfilling statutory requirements, the purposes of the project were:

> 1) to relocate eggs from nests deposited in sites threatened by natural processes or human activities and thus maximize hatchling recruitment,
>
> 2) to accurately survey sea turtle nesting patterns to document historical trends and assess natural and anthropogenic factors affecting nesting patterns and densities,
>
> 3) to assess the success of sea turtle recruitment and of hatchery operations in terms of nesting success, hatching success and total hatchlings released,
>
> 4) to dispose of turtle carcasses, respond to strandings and other emergencies and maintain a hot-line for reporting of turtle incidents, and
>
> 5) to inform and educate the public about sea turtles and their conservation.

MATERIALS AND METHODS

Beach Survey

Daily beach surveys commenced at sunrise or 6:00 AM (whichever was later), except at Fort Lauderdale where early beach cleaning required a slightly earlier start. For survey purposes the County was divided as follows:

BEACH	BEACH LENGTH (km)	BOUNDARIES	DEP SURVEY MARKER #
Hillsboro-Deerfield Beach	7.0	Palm Beach Co. line to Hillsboro Inlet	R1-24
Pompano Beach	7.7	Hillsboro Inlet to Commercial Blvd.	R25-50
Fort Lauderdale	10.6	Commercial Blvd. to Port Everglades Inlet	R51-84
John U. Lloyd Park	3.9	Port Everglades Inlet to Dania Beach fence	R86-97
Hollywood-Hallandale	9.4	Dania Beach fence to Miami Dade Co. line	R98-128

The location of Broward County and the positions of the boundary lines above are shown in Figure 1 A-F.

Daily surveys of Hillsboro-Deerfield, Pompano, Fort Lauderdale and Hollywood-Hallandale beaches commenced on March 1, 2002. Surveys continued through September 30th. The beach at John U. Lloyd State Park was patrolled by park personnel who provided the data for that area. Except in Lloyd Park, nest locations were referenced to FDEP beach survey monuments numbered consecutively from R1 to R128 (N to S). Marker numbers corresponding to each beach area are listed above. Each nest location was initially recorded relative to the nearest building, street,

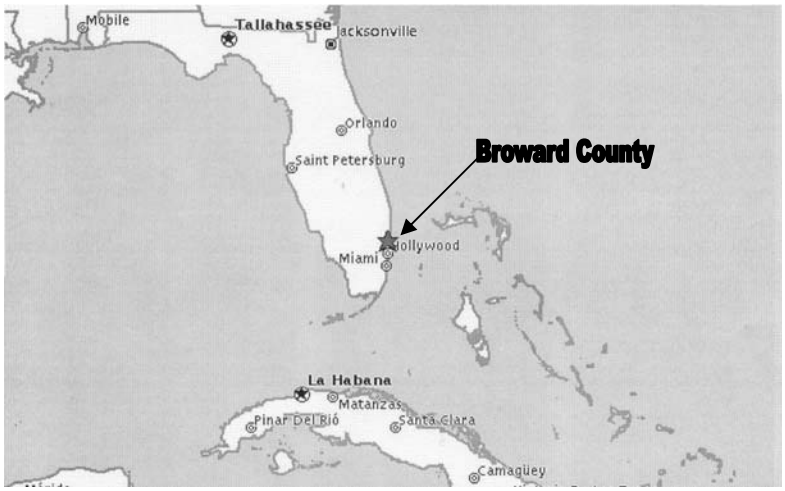

Figure 1A: The location of Broward County, FL

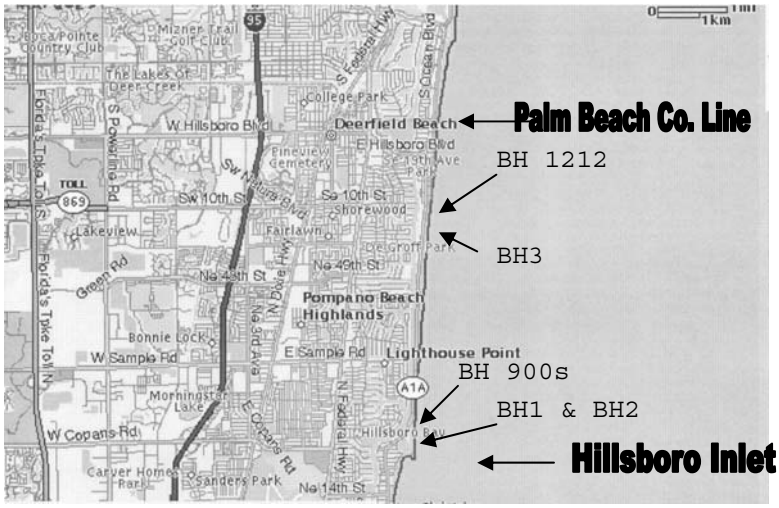

Figure 1B: Northern Broward County, showing locations of southern (BH1) and northern (BH1212) open beach relocation sites.

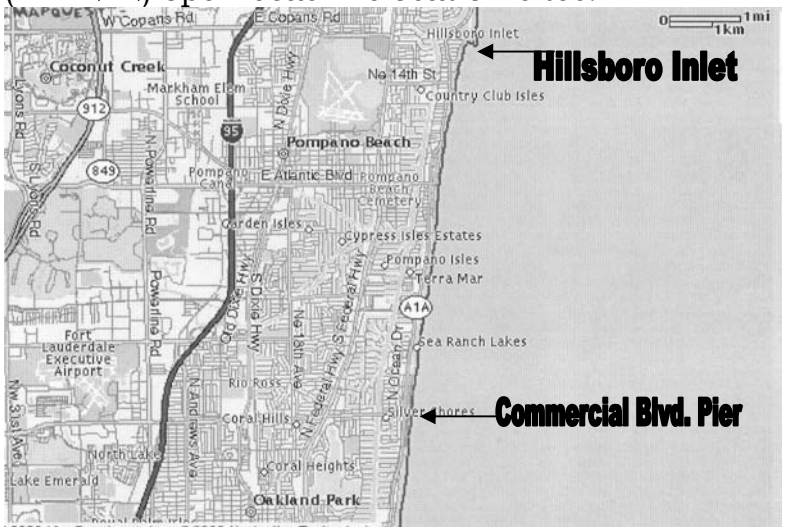

Figure 1C: North Central Broward County.

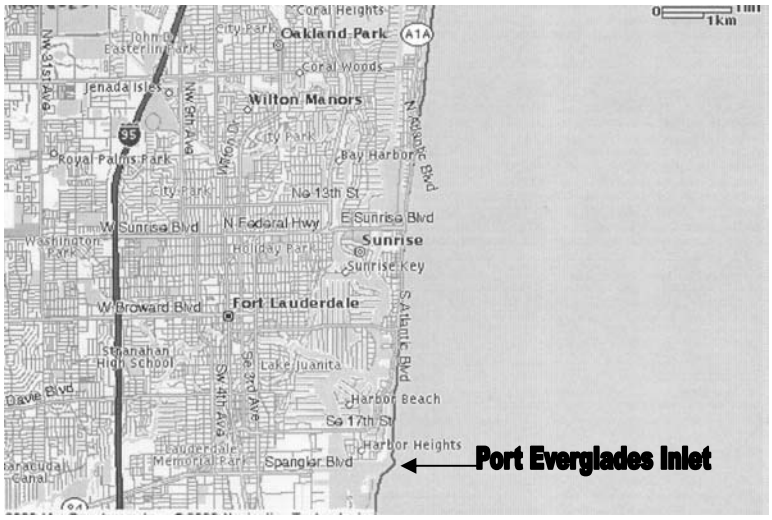

Figure 1D: Central Broward County

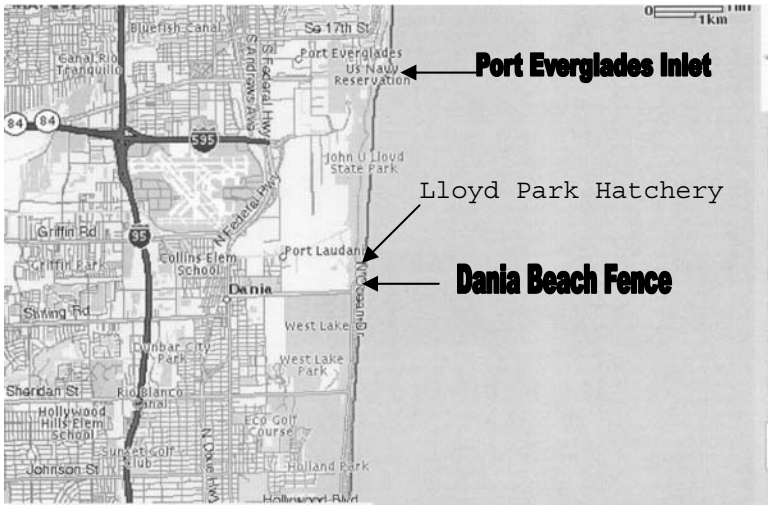

Figure 1E: South Central Broward County, showing the open beach hatchery in Lloyd Park.

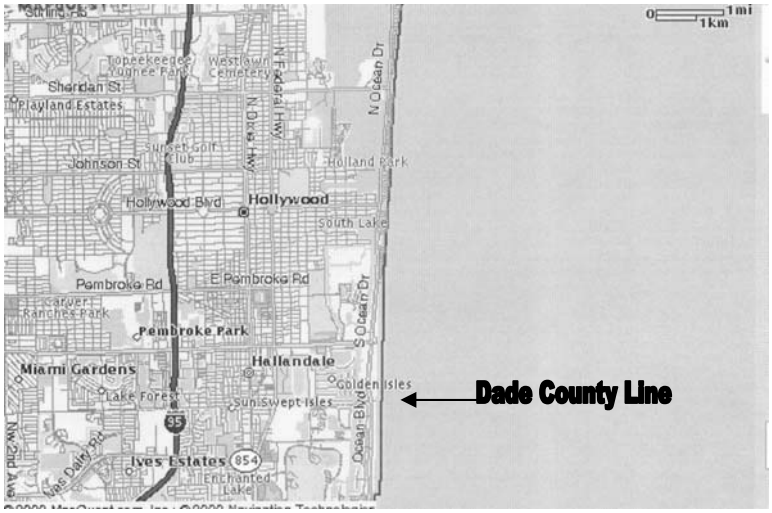

Figure 1F: Southern Broward County

or other landmark. These locations were later cross-referenced to the nearest survey marker. Nest and false crawl locations were also recorded using Global Positioning System (GPS) receivers.

In John Lloyd Park, four 1-km zones (zone 1 farthest north) were used for recording nest locations due to the relative lack of beach landmarks. This was also done to provide continuity with the data collected in Lloyd Park during previous years.

Surveyors used four-wheeled all-terrain vehicles (ATVs) that can carry up to five turtle nests per trip in plastic buckets. The usual method was to mark and record nests and false crawls on the first pass along the beach and then dig and transport nests in danger of negative impacts on the return pass. Due to early beach cleaning in Fort Lauderdale, two workers picked up the nests on the first pass. Nests were transferred, at prearranged meeting sites, to a third person who transported them to their destination by car. Nests were often transported directly on the ATVs to fenced beach hatcheries. When there were many nests requiring relocation, additional trips were occasionally necessary. After recording all pertinent information, the crawl marks were obliterated to avoid duplication.

Nests in danger of negative impacts were defined as follows:

1) a nest located within 20 feet of the previous evening wrack line,

2) a nest located near a highway or artificially lighted area defined as a beach area where a surveyor can see his shadow on a clear night, and

3) a nest located in an area subject to beach nourishment.

Especially due to definition 2, most of the discovered nests at Pompano Beach, Deerfield Beach, Hollywood-Hallandale Beach, and Fort Lauderdale beaches were considered to be in danger of negative impact and therefore were relocated to fenced beach hatcheries or to unfenced beach locations at Hillsboro Beach. The main relocation sites were designated BH1 and BH2, located respectively at the north and south ends of the Hillsboro Club near FDEP survey marker R23, immediately north of the Hillsboro Inlet (Figure 1B). In order to avoid concentrating all nests at one location, nests from other beaches were also relocated to an open beach area designated BH3, near survey marker R9 and along the beach adjacent to homes with house numbers ranging from the 900s to 1212 on Highway A1A. The locations of the most southerly and northerly relocation sites (BH1 and BH1212, respectively) are shown in Figure 1B. Nests in danger of negative impacts that were deposited on Hillsboro Beach were relocated to less hazardous nearby locations on that beach (designated BH). In cases where there was no nearby safe location site, Hillsboro nests were transported by ATV to beach locations adjacent to house numbers in the 1000s (HB1000s) and 1100s (HB1100s). Because the size of the restraining hatchery in Hollywood was greatly reduced due to erosion, most Hollywood nests were relocated to an open beach site just north of the Dania Beach fence in John Lloyd State Park (Figure 1E). These nests were protected with self-releasing flat screens.

Nests to be relocated were carefully dug by hand, and transported in buckets containing sand from the natural nest chamber. The depths of the natural egg chambers were measured and recorded. The eggs were then transferred to hand-dug artificial egg chambers of similar dimensions, which were lined with sand from the natural nest. Care was taken to

maintain the natural orientation of each egg, to prevent possible injury to the embryos.

There were 564 nests that not in danger and were marked with stakes bearing yellow 5.5" X 8.8" sea turtle nest warning signs (Appendix 3) and left *in situ*. After hatching 256 of these nests (34 percent) were excavated for post emergence examination. The number of hatchlings released from each nest was determined as the total number of eggs minus the number of hatchlings found dead in the nest (DIN), dead pipped eggs with partially emerged hatchlings (DPIP), and unhatched eggs showing visible (VD) or no visible development (NVD). The number of hatchlings alive in the nest (LIN) and live pipped eggs (LPIP) were included in the number of hatchlings released but were subtracted from this number to determine the number which naturally emerged from each nest. Hatching success was defined as the number of released hatchlings divided by the total number of eggs.

Restraining Hatcheries

As in previous years, early nests were transferred to chain-link fenced hatcheries located in Pompano Beach near Atlantic Boulevard, at the South Beach municipal parking lot in Fort Lauderdale, or at North Beach Park in Hollywood. After hatching, all hatchery nests were dug, and counts of spent shells, live hatchlings, dead hatchlings, live and dead pipped eggs and eggs with arrested or no visible development were made.

Hatchery nests displaying a depression over the egg chamber were covered with a bottomless plastic bucket to retain hatchlings, although the turtles sometimes escaped these enclosures by digging around them. After hatching commenced, the hatcheries were checked at least twice each day, once between 9:00 PM and midnight and again just prior to 5:00 AM. Hatchlings found in the evening were released that same night in dark

sections of Fort Lauderdale, Hillsboro Beach, Hollywood or Lloyd Park beaches by allowing them to crawl through the intertidal zone into the surf. Hatchlings discovered in the morning in the hatcheries were collected and held indoors in dry plastic buckets in a cool, dark place until that night, when they were released as above.

The Pompano and Fort Lauderdale hatcheries were filled with nests by mid May. Thereafter, nests from these beaches were relocated to Hillsboro Beach. Hollywood nests were relocated to the south end of John Lloyd Park after the restraining hatchery filled. Hatched nests in the restraining hatcheries were completely dug out along with the surrounding sand and replaced with fresh sand. The sand from the old nests was spread outside the hatchery. Fresh sand was obtained from elsewhere on the beach.

Data analysis

The data were compiled, analyzed and plotted primarily with Quattro Pro, version 8 (Corel Corp. Ltd.) and Statistica, release 5.1 (StatSoft, Inc.). The countywide yearly nesting densities from 1981 to 2002 for the three species were plotted and trends were assessed by linear regression and correlation analyses. Seasonal nesting patterns and nesting densities were calculated for each beach (nests per km) and the beaches were compared using 1-way analysis of variance (ANOVA) and Newman-Keuls (NK) tests at the 0.05 significance level. The total number of nests deposited by each species in the beach segments corresponding to each FDEP survey marker was tabulated and plotted. GPS positions for most nests and false crawls were also plotted on the 1996 Broward County Coastline Aerial Shore Line Map using the ArcView Geographic Information System (GIS) but due to the size of the printouts, these data will be presented as a separate DPEP report.

Total nesting success (nests/total crawls) for each species at each beach was computed and the mean daily nesting success of loggerheads and greens at each beach was compared by ANOVA and NK analyses. The average nesting success in each zone was also plotted versus its FDEP survey number. The numbers of eggs and live hatchlings of each species in relocated and evaluated *in situ* nests were recorded and the hatching successes were determined. The overall hatching success of all eggs from relocated and *in situ* nests were plotted from 1981 through 2002. The frequency distribution of the hatching success of *in situ* and relocated loggerhead nests were plotted and compared with the Mann-Whitney U-test. The mean hatching percentages and proportions of the post-hatching egg categories (LIN, LPIP, DIN, DPIP, VD and NVD) were tabulated by species from nests deposited or relocated at each of the individual beaches or relocation sites.

RESULTS

Figure 2 shows the historical trend in the total number of sea turtle nests deposited in Broward County since 1981. A total of 2311 nests were found in 2002. While this was only 74 nests less than alst year, it represents a 21 percent decline from the peak in 2000.

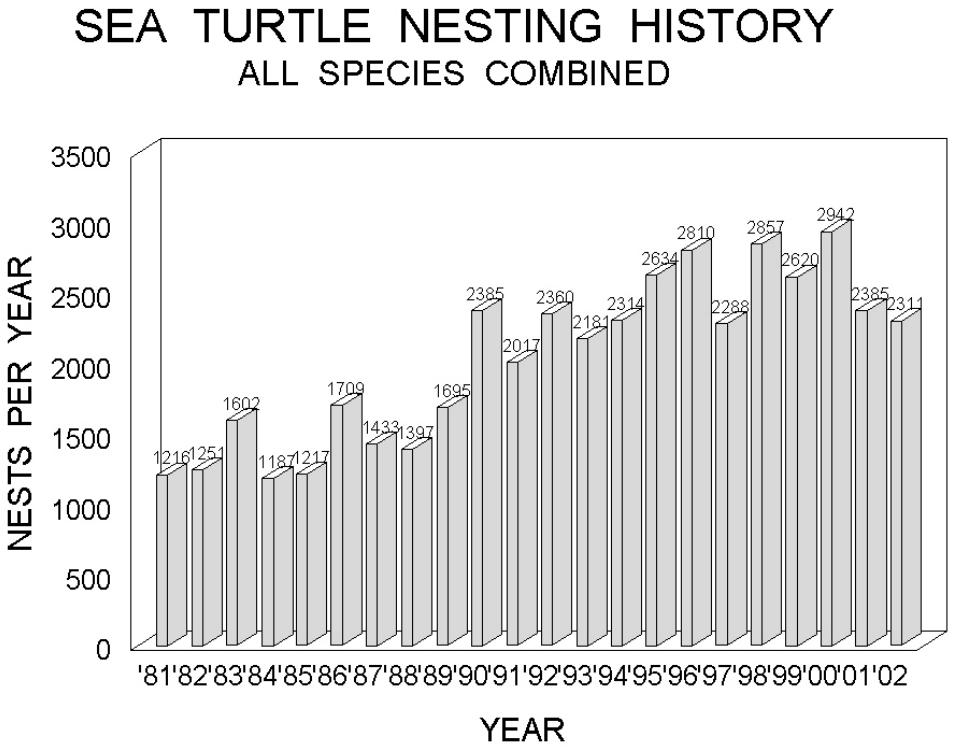

Figure 2: The pattern of total sea turtle nesting in Broward County since full surveys commenced in 1981.

Figure 3 shows the yearly nesting trends of loggerhead, green and leatherback sea turtles. The loggerhead nest count declined for the second consecutive year, dropping 22 percent since 2000. Such a large two-year down trend has not been seen since project inception. However, the trend line remains highly significant and its slope indicates an average increase

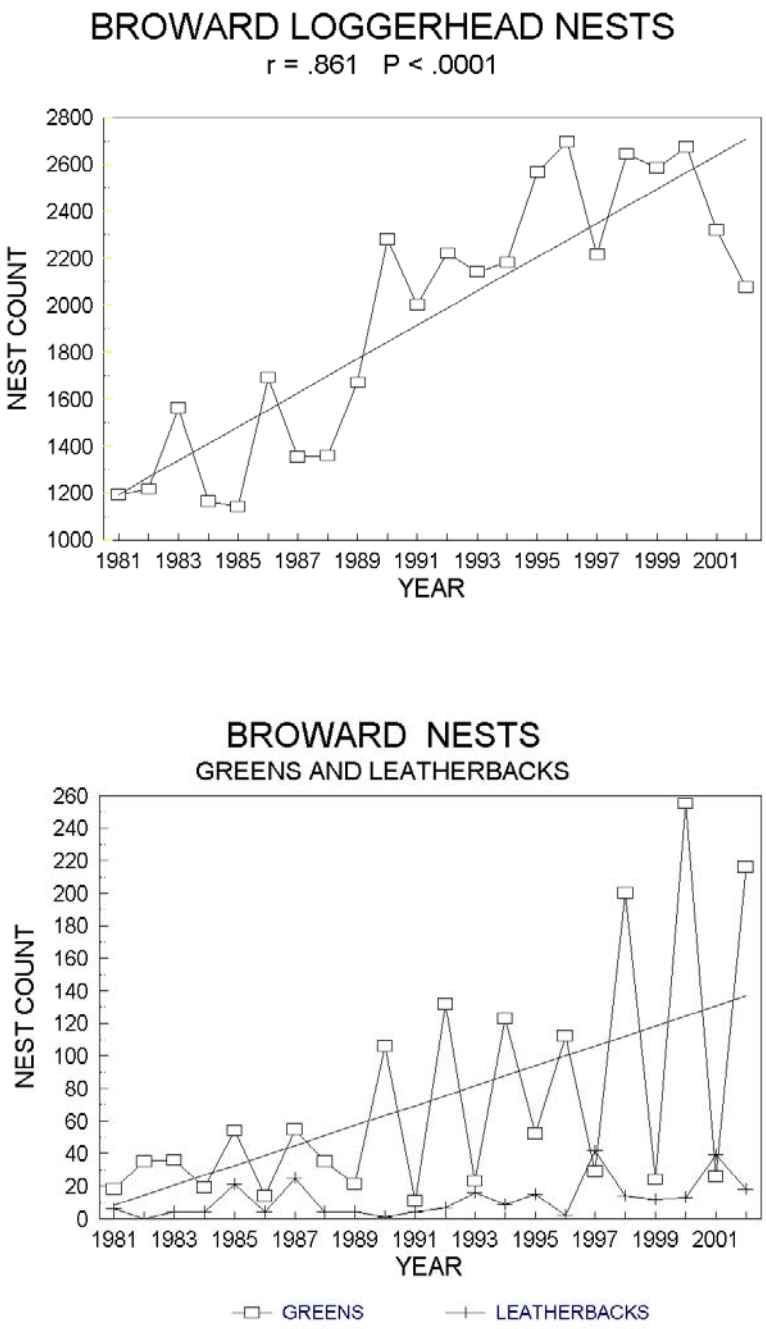

Figure 3: Historical nesting patterns of loggerhead, green and leatherback sea turtles in Broward County since 1981.

of 72.3 nests per year since 1981. This was not significantly lower than last year.

Nesting by the green sea turtle increased dramatically to its second highest level since 1981 (Fig. 3). Since 1990, nesting has increased in even

numbered years and declined in odd years. This year was the seventh consecutive even numbered year with elevated nesting. Even with the large fluctuations, the slope of the 22-year trend line for green turtle nesting is significantly greater than zero ($r = 0.491$; $P < .004$), suggesting an average increase of 6.13 nests per year since 1981. Eighteen leatherback nests were deposited in 2002. While this was down form last year, the count is still well above the 22 year average of 12 nests per year. While slightly higher nesting since the early 1990s has caused a significant upward nesting trend ($r = .491$; $P = .010$) it is risky to predict that the trend will continue.

Figure 4 shows the seasonal loggerhead nesting pattern. The first and last nest were deposited on 12 April in Pompano Beach and on 10 September in Hillsboro Beach. Table 1 and Figure 5 give the total loggerhead nesting densities and seasonal patterns for the five beaches. Nesting densities (mean daily nests/km) at Hillsboro Beach and Pompano Beach were highest in the County and statistically indistinguishable. Nesting in Fort Lauderdale and Lloyd Park was intermediate and Hollywood was significantly lower than all other beaches. This is the same pattern observed in 2001.

The countywide seasonal nesting patterns of greens and leatherbacks are shown in Figure 6 and for the individual beaches in Figure 7. The first and last leatherback nests were deposited on 2 March and 7 June. Green turtles nested between 22 May and 26 September. Nesting densities for greens and leatherbacks are shown in Table 2 and Table 3, respectively. Nesting by greens was highest in Hillsboro Beach, followed by Lloyd Park, with lower nesting in Fort Lauderdale, Pomopano Beach and Hollywood. Leatherback nesting was highest in Hillsboro Beach and lowest in Lloyd

Park, But there were no significant differences in mean daily nesting densities throughout the County.

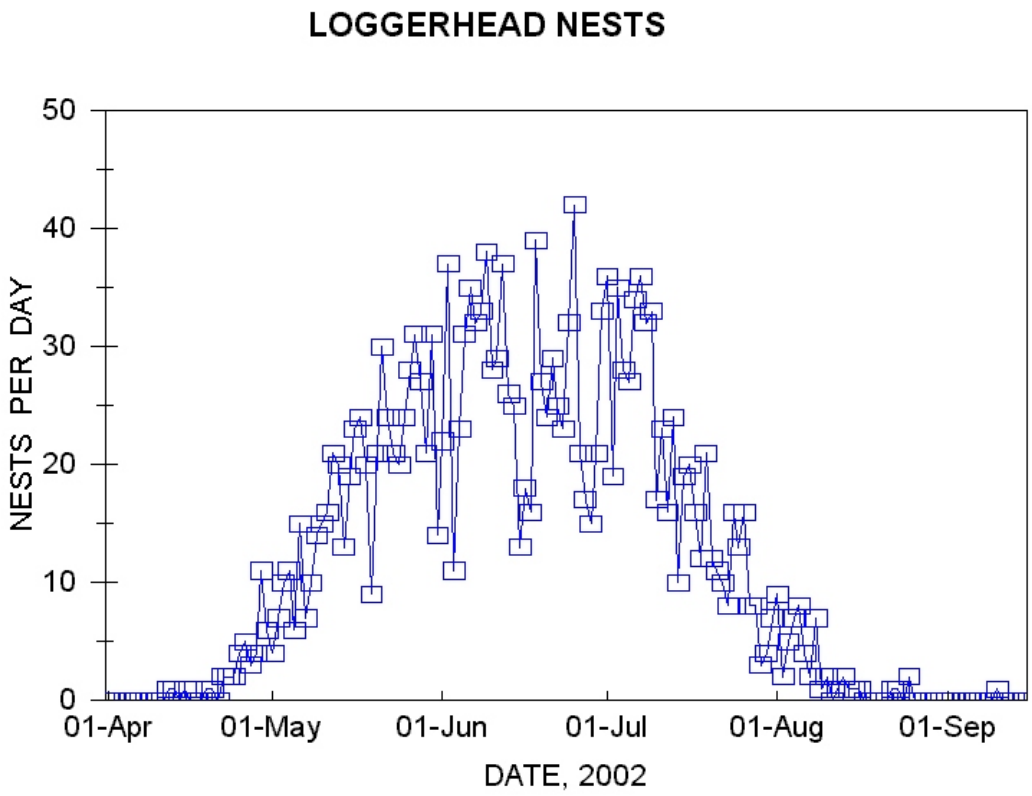

Figure 4: The seasonal pattern of daily loggerhead nesting in Broward County, 2002.

Table 1: Total loggerhead nests and nesting densities expressed as nests-per-kilometer for the 2002 season. Beaches with the same NK designation letters were not significantly different in a Newman-Keuls test (α = .05) of mean daily nesting per km. Beaches with different NK letters had significantly different nesting densities.

BEACH	TOTAL NESTS	BEACH LENGTH (km)	Nests per km	MEAN DAILY NESTS per km with NK Designation Letter	
Hillsboro Beach	565	7.0	80.7	.480	A
Pompano Beach	607	7.7	78.8	.454	A
Lloyd Park	204	3.9	52.3	.311	B
Ft. Lauderdale	562	10.6	53.0	.308	B
Hollywood	139	9.4	14.8	.082	C
OVERALL	2077	38.6	53.8		

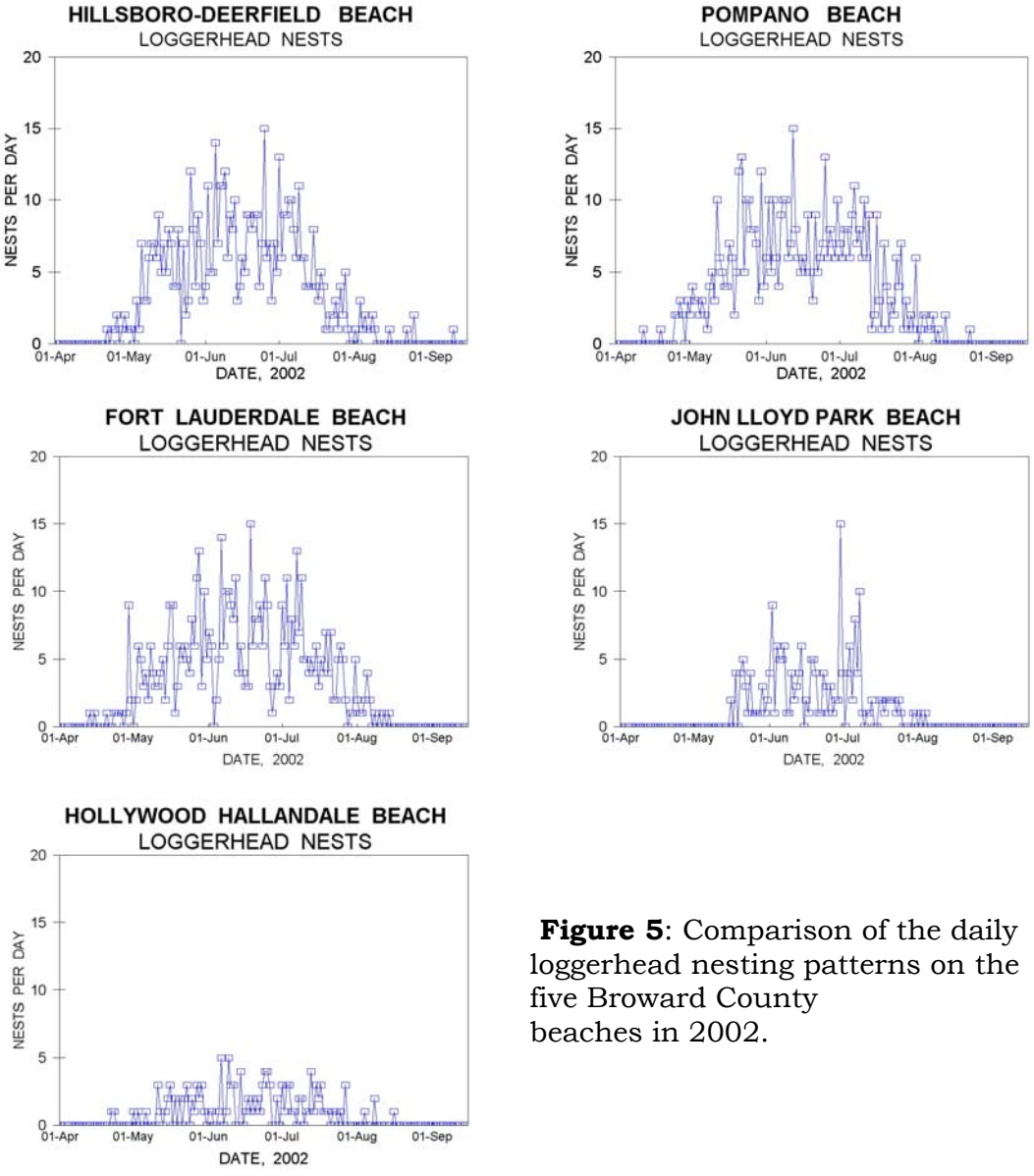

Figure 5: Comparison of the daily loggerhead nesting patterns on the five Broward County beaches in 2002.

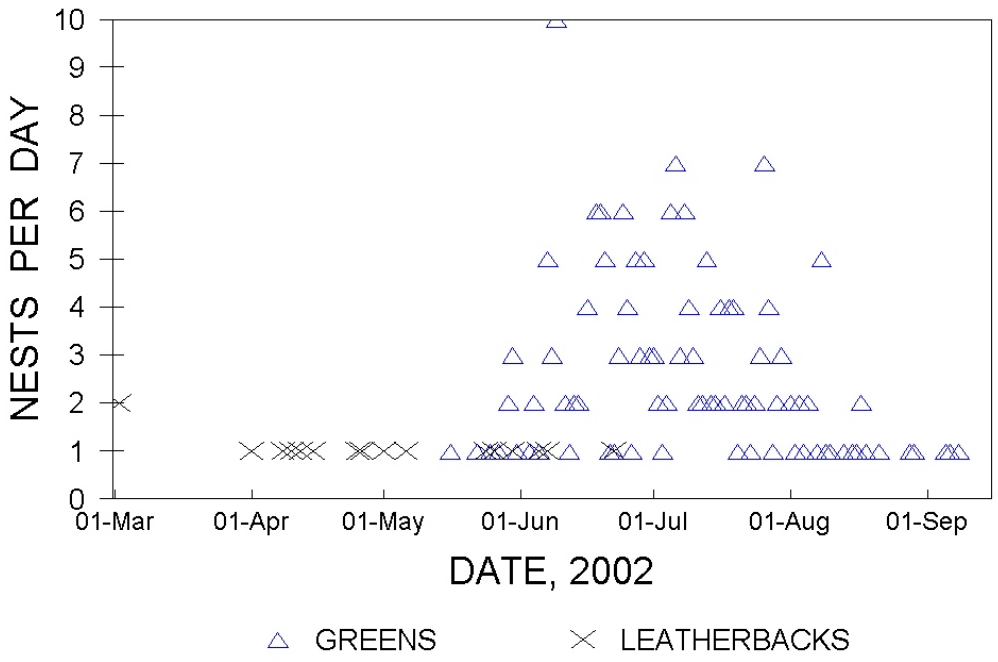

Figure 6: The seasonal pattern of daily green and leatherback nesting in Broward County, 2002.

Figure 8 shows nest counts for each species in each 1000-foot zone of Broward County beach (1-km zones in Lloyd Park) during 2002. As in previous years, the low nesting zones R-2, R-24, R-34 and R-50 are near the Deerfield Beach Pier, the Hillsboro Inlet, the Pompano Beach Pier and the Commercial Boulevard pier, respectively. The beach along the Fort Lauderdale strip (R-61 to R-78) and the entire beach south of R-98 were also lightly nested. Loggerhead nesting was unusually heavy in zone R-21, in the residential section of Hillsboro Beach. Green turtles nested throughout the County, but more heavily in Hillsboro Beach and Lloyd Park. Leatherbacks also nested Countywide, but preferred Hillsboro Beach.

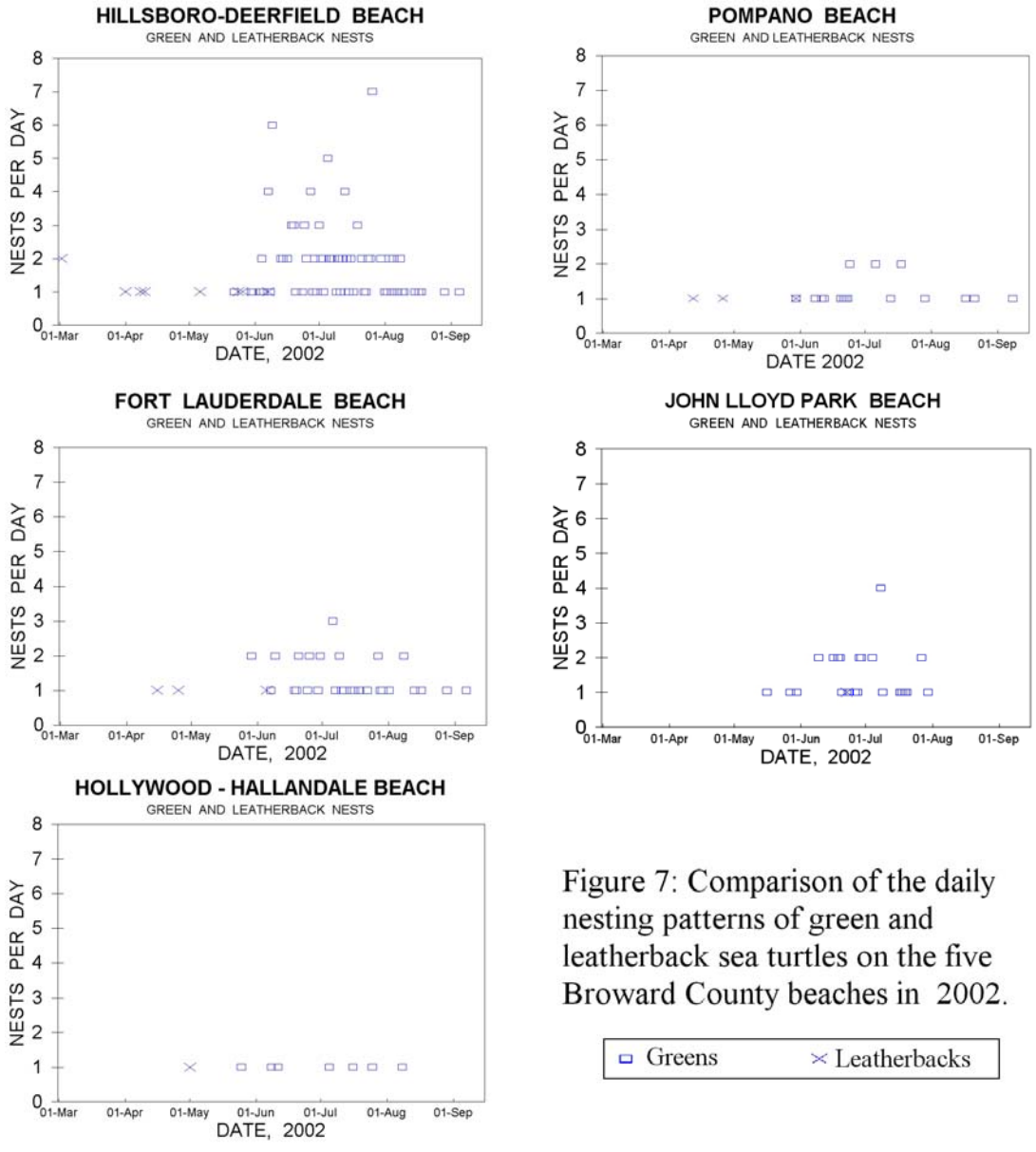

Figure 7: Comparison of the daily nesting patterns of green and leatherback sea turtles on the five Broward County beaches in 2002.

Table 2: Total green turtle nests and nesting densities expressed as nests-per-kilometer for the 2001 season. Beaches with the same NK designation letters were not significantly different in a Newman-Keuls test (alpha = .05) of mean daily nesting per km. Beaches with different NK letters had significantly different nesting densities.

BEACH	TOTAL NESTS	BEACH LENGTH (km)	Nests per km	MEAN DAILY NESTS per km with NK Designation Letter
Hillsboro Beach	116	7.0	16.6	.0978 A
Lloyd Park	33	3.9	8.4	.0504 B
Ft. Lauderdale	40	10.6	3.8	.0213 C
Pompano Beach	20	7.7	2.6	.0147 C
Hollywood	7	9.4	0.7	.0044 C
OVERALL	216	38.6	5.6	

Table 3: Total leatherback nests and nesting densities expressed as nests-per-kilometer for the 2002 season. One-way ANOVA detected no differences in mean daily nesting densities.

BEACH	TOTAL NESTS	BEACH LENGTH (km)	Nests per km	MEAN DAILY NESTS per km
Hillsboro Beach	9	7.0	1.3	.0050
Pompano Beach	4	7.7	0.5	.0020
Ft. Lauderdale	3	10.6	0.3	.0014
Lloyd Park	1	3.9	0.3	.0013
Hollywood	1	9.4	0.1	.0005
OVERALL	18	38.6	0.5	

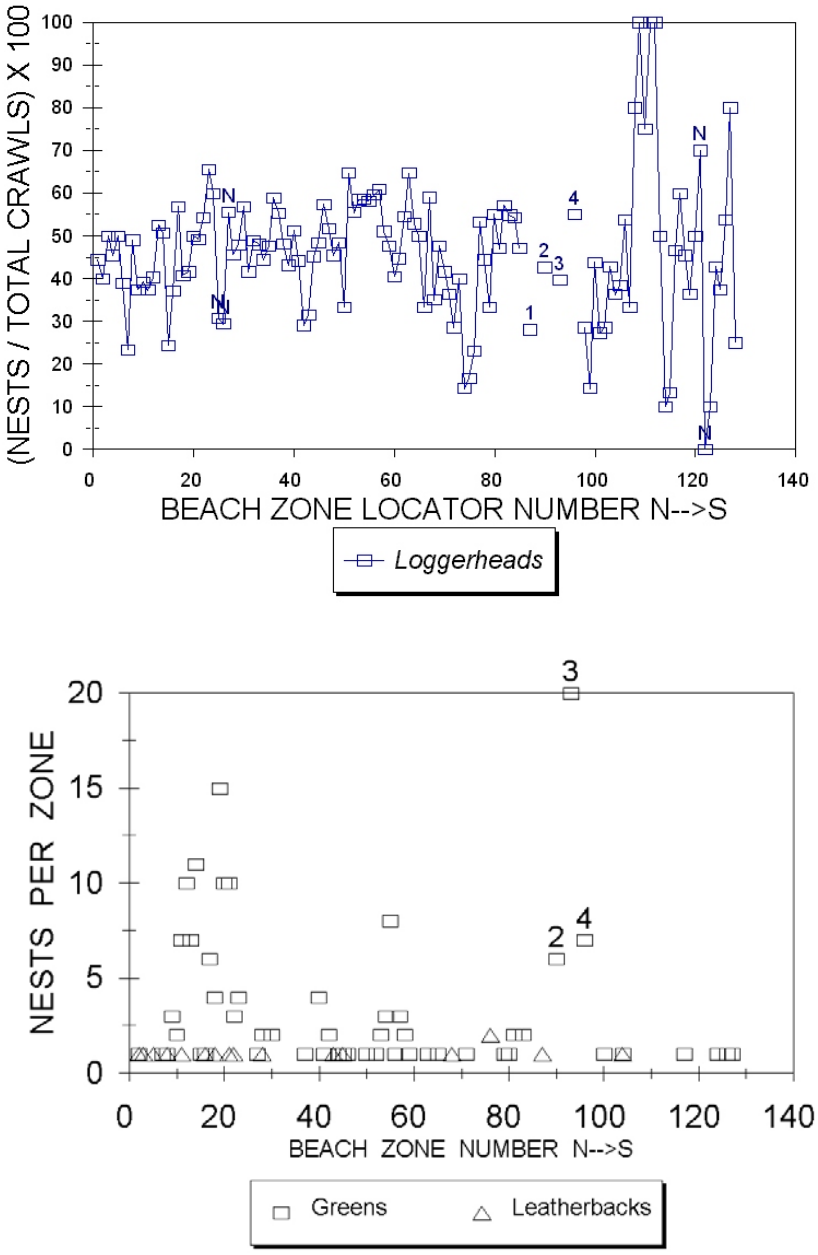

Figure 8: Locations of loggerhead, green and leatherback nests in Broward County, 2002. Numbers 1-4 indicate the four beach zones of John Lloyd Park. Zones R25-27 and R121-122 which were renourished prior to the nesting season are marked with the letter **N** in the loggerhead graph.

Figure 9 and Table 4 present the countywide distribution of nesting success for the three species. Loggerhead nesting success showed no recognizable pattern except for lower values in zones R74-76 on the Fort Lauderdale strip. The large fluctuations in Hollywood reflect the small number of sea turtle emergences in this area. Nesting success was highest in Fort Lauderdale and Pompano Beach, and significantly lower in Lloyd Park. Hollywood and Hillsboro Beach were intermediate between these groups. One-way ANOVA showed no significant differences in the nesting success of greens or leatherbacks throughout the County.

Table 5 gives the number of nests for each species that were relocated to Hillsboro Beach or to fenced hatcheries, as well as the numbers of nests left *in situ*. Table 6 lists the number of eggs and released hatchlings from evaluated *in situ* and relocated nests. The numbers of predated nests and nests that were unevaluated due to stake removal or washout are also listed.

The 59.7 percent hatching release rate of relocated loggerhead nests (Table 6) declined by 6.8 percentage points from last season, while the 80.8 percent success of *in situ* loggerheads increased by 0.9 points. This difference was highly significant. The hatching success of *in situ* greens was the same as for loggerheads and the success of *in situ* leatherback nests was slightly higher. Relocated green and leatherback nests had hatchling release rates of 48.7 and 52.8 percent, respectively.

Figure 10 shows the seasonal patterns of the hatching success of *in situ* and relocated loggerhead nests. Hatching success in both groups showed very significant seasonal declines but the slope of the regression line was significantly higher for relocated nests ($p<.001$). Figure 11 shows

the seasonal hatching success for relocated and *in situ* green turtle nests. Both showed significant seasonal declines, but the slopes were not significantly different (P = .15).

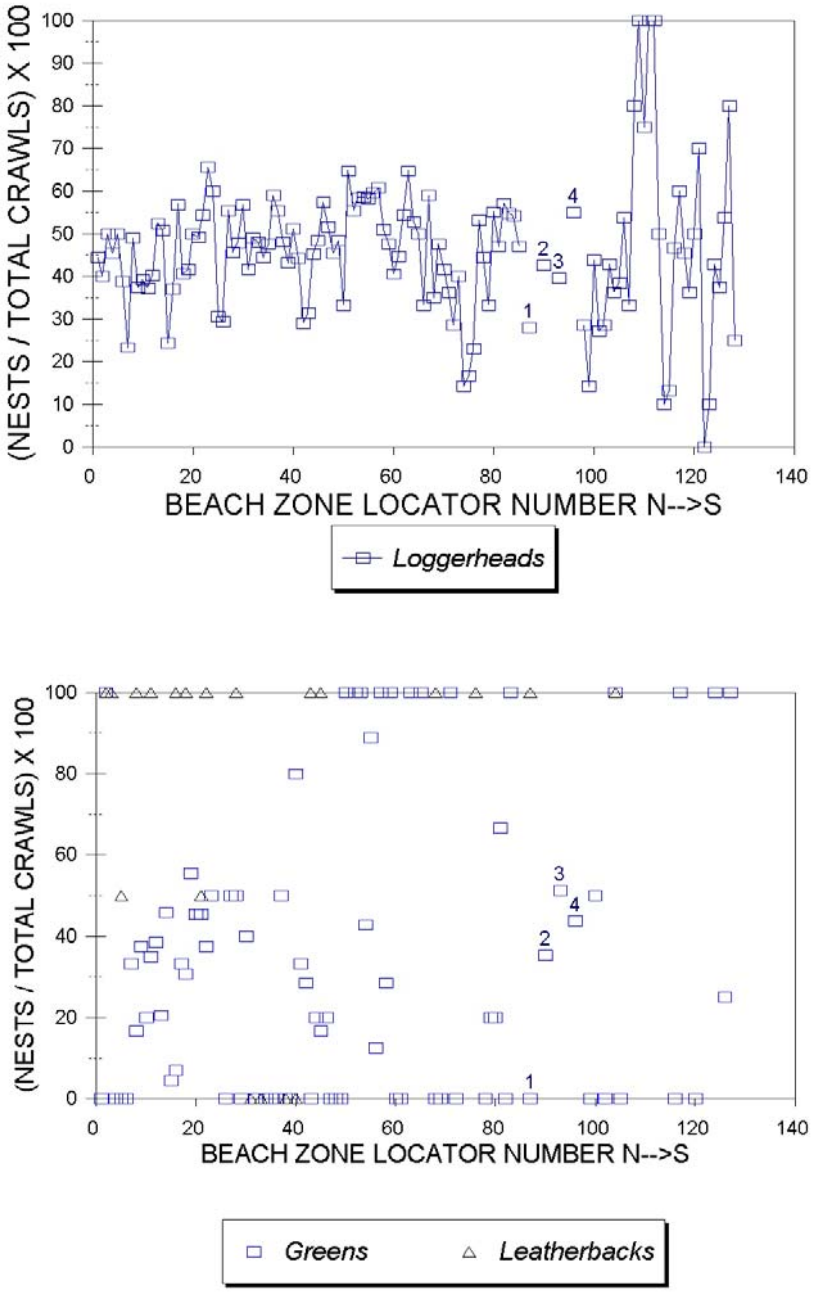

Figure 10: The distribution of the nesting success of loggerhead, green and leatherback turtles across Broward County, 2001. Numbers 1-4 indicate the four beach zones of John Lloyd Park.

Table 4: Total nests, false crawls (FC) and percent nesting success (NS) for three sea turtle species on each of five Broward County beaches during 2002. Newman-Keuls (NK) designations for loggerheads as in Table 2. One-way ANOVA detected no significant differences in nesting success for greens or leatherbacks.

BEACH	**Loggerheads**				**Greens**			**Leatherbacks**		
	Nests	FC	NS	NK	Nests	FC	NS	Nests	FC	NS
Ft. Lauderdale	562	519	52.0	A	40	37	51.9	3	0	100
Pompano Beach	607	641	48.6	A	20	55	26.4	4	4	50.0
Hillsboro Beach	565	692	44.9	AB	116	197	37.1	9	2	81.8
Hollywood	139	176	44.1	AB	7	10	41.2	1	0	100
Lloyd Park	204	294	41.0	B	33	44	42.9	1	0	100
OVERALL	2077	2322	47.2		216	343	38.6	18	6	75.0

Table 5: Total Number of loggerheads, greens leatherback nests relocated to Hillsboro beach or fenced hatcheries or left *in situ*. Lloyd Park is not included.

	Loggerheads	Greens	Leatherbacks	Totals
RELOCATED				
<u>Open Beach</u>				
Hillsboro Beach				
BH	9	0	0	9
BH1	102	0	0	102
BH2	117	5	1	123
BH900s	461	26	1	488
BH1000s	55	3	0	58
BH1100s	54	5	1	60
BH1125-35	8	0	0	8
BH1212	7	0	0	7
BH3	397	29	0	426
Pompano Beach	1	0	0	1
Lloyd Park Beach	98	6	0	104
<u>Hatcheries</u>				
Pompano	49	0	1	50
Ft. Lauderdale	45	0	1	46
Hollywood	27	0	0	27
TOTALS	1430	74	5	1509
IN SITU				
Hillsboro Beach	360	100	7	467
Pompano Beach	38	5	2	45
Ft. Lauderdale	31	3	2	36
Hollywood	14	1	1	16
TOTALS	443	109	12	564
GRAND TOTALS	1873	183	17	2073

Table 6: Total egg counts, released hatchlings and overall release successes for *in situ* and relocated nests of loggerheads, greens and leatherbacks in 2002.

SPECIES	NUMBER OF EGGS	EVAL. NESTS	HATCHLINGS RELEASED	RELEASE SUCCESS (%)
***In situ* Nests**				
C. caretta	22309	209	18026	80.8
C. mydas	5034	42	4067	80.8
D. coriacea	434	5	379	87.3
Total	27777	256	22472	80.9
Relocated Nests				
C. caretta	130062	1185	77698	59.7
C. mydas	7080	55	3451	48.7
D. coriacea	235	2	124	52.8
Total	137377	1242	81273	59.2
Overall				
C. caretta	152371	1394	95724	62.8
C. mydas	12114	97	7518	62.1
D. coriacea	669	7	503	75.2
TOTAL	165154	1498	103745	62.8
Predated and Unevaluated Nests and Eggs				
	Predated Nests	Pred. Eggs	Unevaluated Nests	Unevaluated Eggs
***In Situ* Nests**				
C. caretta	38	-	195	-
C. mydas	8	-	59	-
D. coriacea	0	-	7	-
Relocated				
C. caretta	111	13322	135	15256
C. mydas	16	2023	3	375

D. coriacea	1	91	2	85

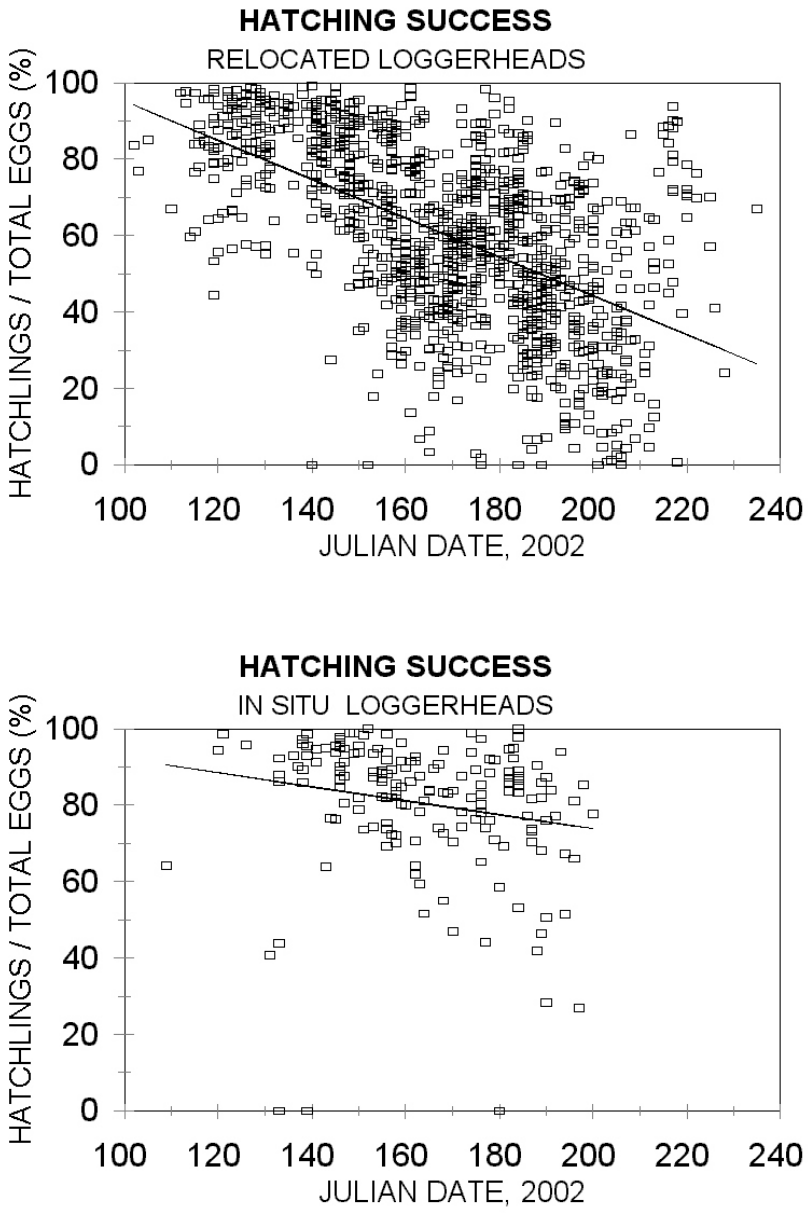

Figure 10: Comparison of seasonal hatching success for relocated and *in situ* loggerhead nests during 2002.

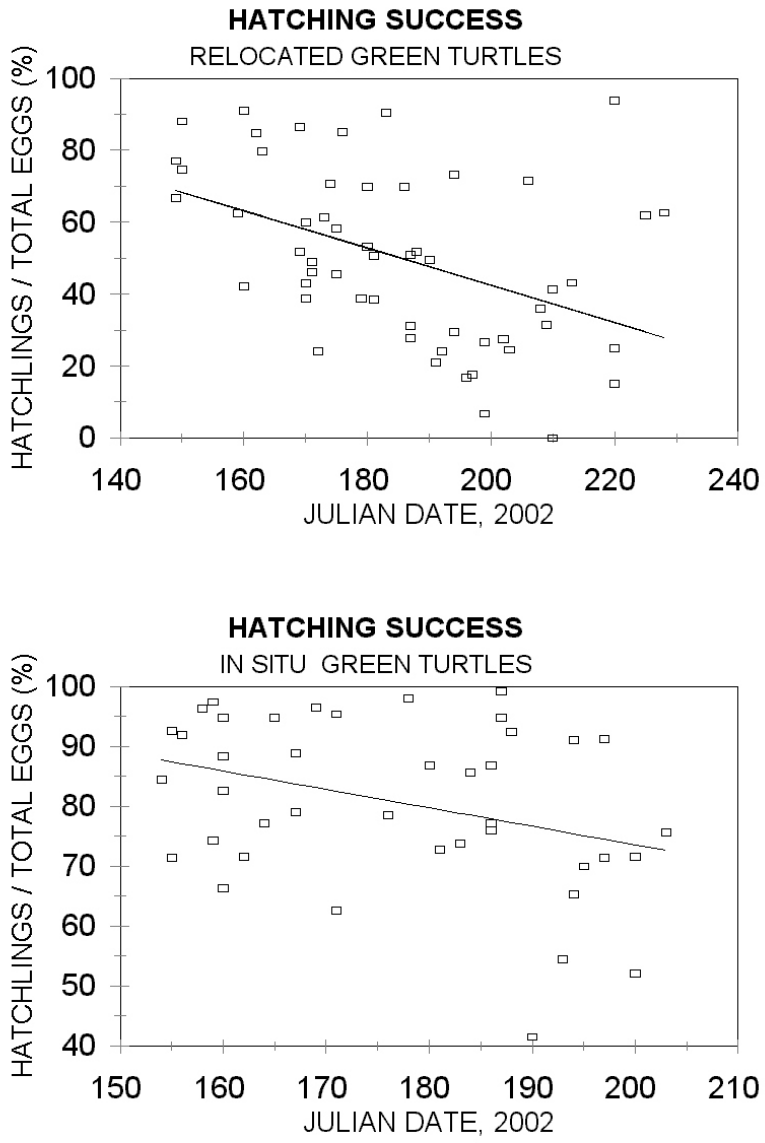

Figure 11: Comparison of seasonal hatching success for relocated and *in situ* green turtle nests in 2002.

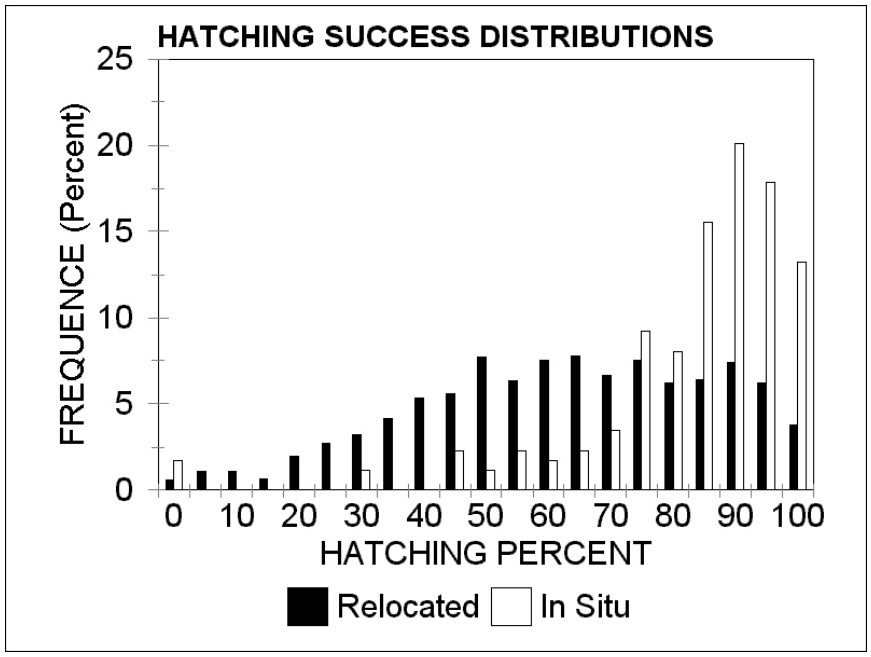

Figure 12: Hatching success frequencies for *in situ* and relocated loggerhead nests in 2002.

Figure 12 shows the frequency distributions for hatching success in relocated and *in situ* nests. A Mann Whitney U test indicated a very significant difference in the medians of these distributions ($Z = 11.5$; $p << .001$).

Figure 13 illustrates the historical patterns of the yearly hatching success of all species combined, since 1981. Overall hatching success of all species combined (59.2 %) declined 6.9 percentage points from last year, while the combined success of in situ nests (80.9 %) increased by 1.2 points (Table 6).

Table 7 compares emergence success and the percentages of hatchlings and eggs in the post-hatching evaluation categories for

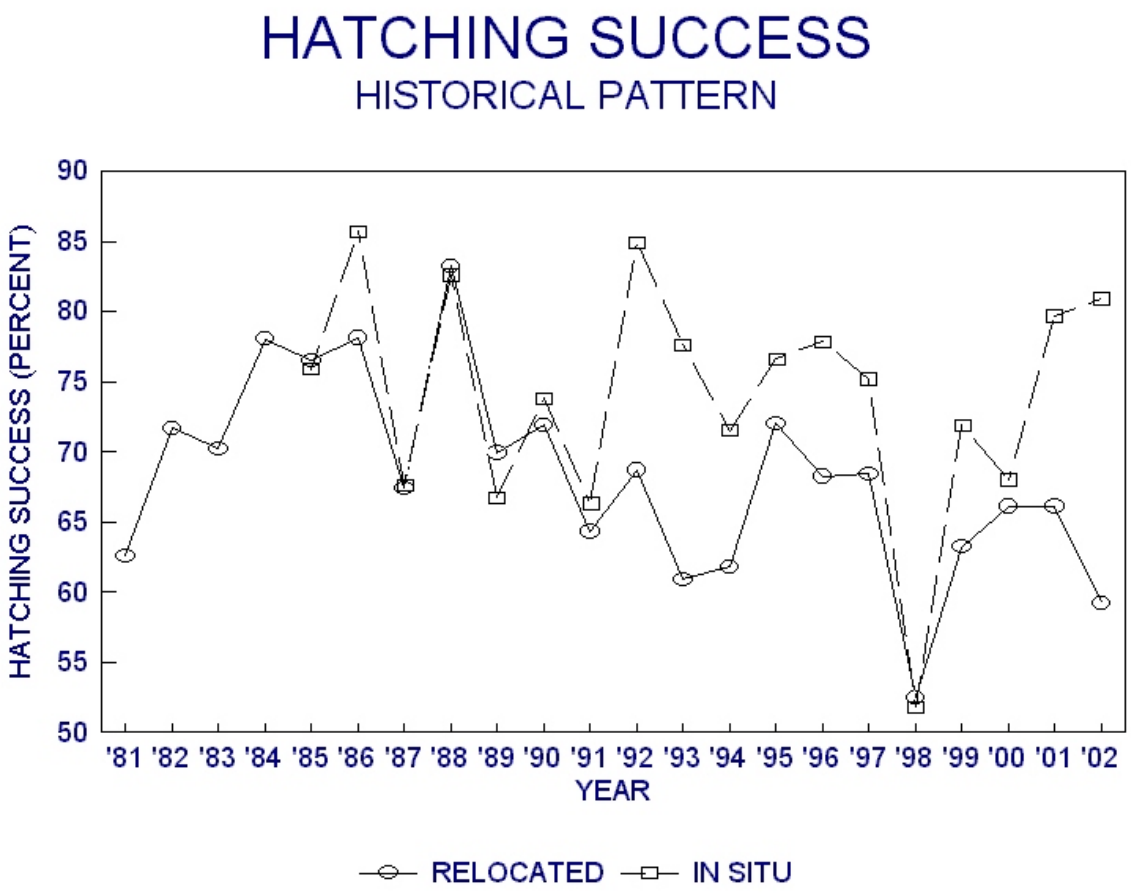

Figure 13: The historical patterns of yearly hatching success for all evaluated *in situ* and relocated sea turtle nests, since 1981.

relocated and *in situ* loggerhead nests. Tables 8 and 9 give the same results for greens and leatherbacks, respectively.

Figure 14 compares the hatchling release success of nests left in situ on Hillsboro Beach and those relocated to BH3 and BH900s.

Table 7: Accounting of the status of all hatched and unhatched eggs in investigated *in situ* and relocated loggerhead nests during 2002.

Location	Total Eggs	Emerged Hatchlings (%)	LIN (%)	DIN (%)	PIP Live (%)	PIP Dead (%)	VD (%)	NVD (%)
***In situ* Nests**								
Hillsboro Beach	17728	74.7	5.4	2.0	0.5	5.9	5.7	5.7
Pompano Beach	1822	81.4	3.8	1.9	0.4	1.8	5.7	4.9
Ft. Lauderdale	1744	66.0	7.2	2.8	0.2	2.7	6.4	14.6
Hollywood Beach	1015	78.9	8.0	2.9	0.4	2.7	1.2	6.0
Relocated Nests								
Hillsboro Beach								
BH	1018	61.4	8.6	3.2	0.8	13.4	6.5	6.1
BH1	3176	61.6	9.0	2.2	1.9	13.2	3.0	9.0
BH2	9588	51.4	10.2	4.7	1.5	17.2	6.7	8.3
BH900s	40809	34.8	9.7	3.2	1.4	15.0	16.8	15.5
BH1000s	4951	48.7	11.7	2.7	2.5	18.3	7.8	8.3
BH1100s	4016	50.5	11.4	3.0	2.7	16.9	6.3	9.2
BH1125-35	545	61.5	13.4	2.6	4.4	8.8	0.4	9.0
BH1212	521	63.3	14.4	0.0	3.5	6.0	5.2	7.5
BH3	42487	41.4	13.6	3.0	2.3	16.1	13.8	9.8
Lloyd Park Beach	8704	52.5	9.0	6.1	2.3	14.5	3.5	12.0
Hatcheries								
Pompano	5876	65.1	13.6	2.5	3.7	8.4	2.2	4.5
Ft. Lauderdale	5395	73.2	9.1	1.4	2.4	5.7	0.9	7.4
Hollywood	2976	75.9	8.7	1.8	1.2	1.7	1.5	9.1

Emerged Hatchlings - Percentage of hatchlings released minus DIN and LIN
DIN - Hatchlings found dead in the nest when it was excavated
LIN - Hatchlings found alive in the nest when it was excavated
PIP-Live - Live hatchlings that partially emerged from their eggs.
PIP-Dead - Dead hatchlings that partially emerged from their eggs.
VD - Unhatched eggs with signs of visible embryo development when opened
NVD - Unhatched eggs with no signs of embryo development

Table 8: Accounting of the status of all hatched and unhatched eggs in investigated *in situ* and relocated green sea turtle nests during 2002. Abbreviations as in Table 7.

Location	Total Eggs	Emerged Hatchlings (%)	LIN (%)	DIN (%)	PIP Live (%)	PIP Dead (%)	VD (%)	NVD (%)
***In situ* Nests**								
Hillsboro Beach	4532	71.3	8.5	1.9	0.5	7.0	4.7	6.1
Pompano Beach	502	57.4	27.7	1.8	0.8	8.4	1.6	2.4
Relocated Nests								
Hillsboro Beach								
BH2	645	64.2	5.1	0.8	1.7	10.1	6.4	11.8
BH900s	2749	19.9	11.3	2.3	2.9	15.5	27.9	20.1
BH1000s	157	22.3	12.7	1.9	3.8	26.8	24.2	8.2
BH1100s	141	66.0	17.7	0.7	2.8	2.8	7.1	2.8
BH3	2736	37.7	13.8	1.5	2.1	7.4	20.5	16.9
Hatcheries								
Lloyd Park Beach	652	52.8	8.0	3.4	1.4	8.4	8.4	17.7

Table 9: Accounting of the status of all hatched and unhatched eggs in investigated *in situ* and relocated leatherback nests during 2002. Abbreviations as in Table 7.

Location	Total Eggs	Emerged Hatchlings (%)	LIN (%)	DIN (%)	PIP Live (%)	PIP Dead (%)	VD (%)	NVD (%)
***In Situ* Nests**								
Hillsboro Beach	338	85.8	2.4	0.0	0.0	1.2	3.6	7.1
Pompano Beach	96	84.4	0.0	0.0	0.0	0.0	2.1	13.5
Relocated Nests								
Hatcheries								
Pompano	110	30.0	5.5	2.7	0.9	22.7	17.3	20.9
Ft.Lauderdale	125	53.6	13.6	0.0	0.0	0.8	9.6	22.4

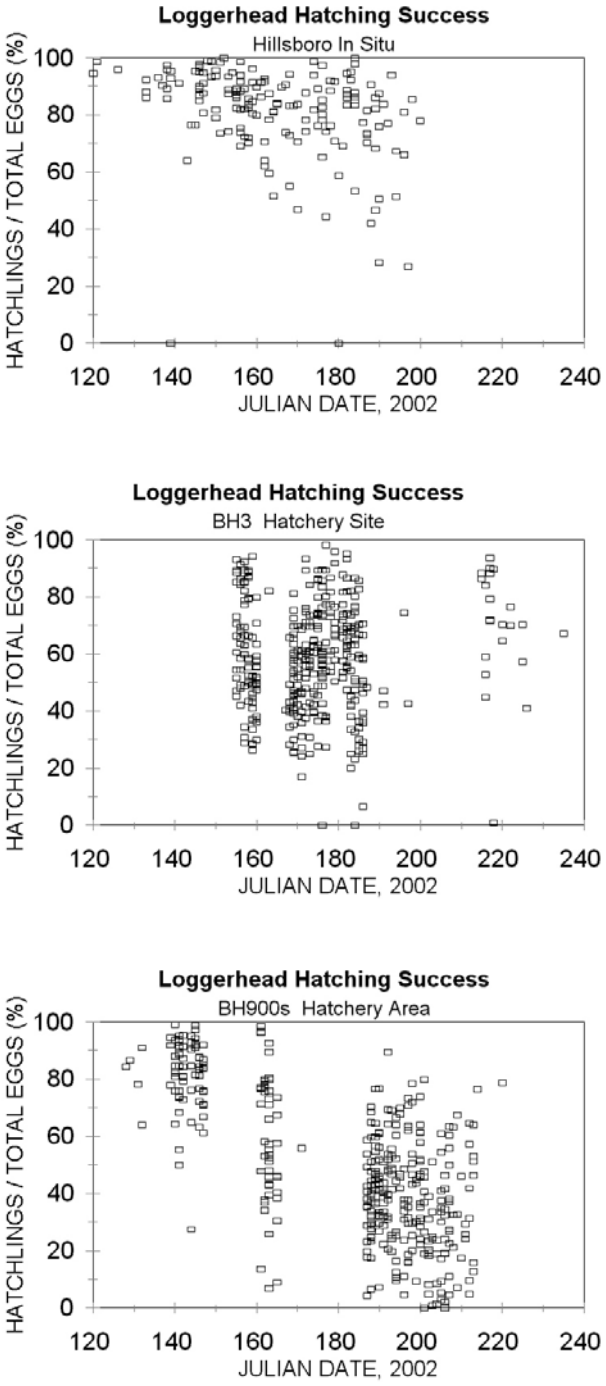

Figure 14: Comparison of the percentages of released hatchlings from in situ nests at Hillsboro Beach and those relocated to hatchery sites BH3 and BH900s.

DISCUSSION

Yearly Nesting Trends

This year's loggerhead nest count declined substantially for the second consecutive year. The last two year down trend occurred from 1983 to 1985 and the decline was much smaller in the second year (Fig. 3). The decline from 2000 to 2002 represents the largest sustained downward trend since project inception. Total nesting for all species (Fig. 1) also declined, but not a dramatically as for loggerheads because of the large increase in green turtle nesting.

As discussed in last year's report (Burney and Ouellette, 2001) decreased nesting can be caused by an overall reduction in the size of the population, a smaller proportion of the female population entering the nesting phase in a given year, or a decrease in the average number of nests deposited per nesting female. A decrease in the population size can be caused by increased mortality, decreased recruitment or emigration. Population size was not assessed, but increased mortality is a possibility due to the unusual outbreak of lethargic loggerhead syndrome (****ref from Ali Millers proposal). A reduction in the proportion of the adult female population that nests in a given year, due to an increase in the remigration interval, may result if poorer feeding conditions or increased energy expenditure increase the time required for sufficient fat reserves to accumulate to allow for the completion of vitellogenesis. The remigration interval can range from 1 to 9 years (Miller, 1997). The average number of clutches deposited per nesting female has been reported to vary from 4.18 to 2.81 nests/female (Richardson, 1985). Fluctuations in the latter two variables could easily account for the recent decline in loggerhead nesting

without requiring a decrease in the adult population size. However, the unprecedented two-year nesting decline is ominous and if it continues next year, it could suggest increased threat to the locally nesting population.

The large increase in green turtle nesting was expected because of the pattern established over the last decade (Fig3). Apparently, a large proportion of the females have maintained a two year remigration interval. The leatherback nest count declined from last year but remains above the 22 year average. There is a suggestion of increased nesting during the past decade, but the trend is tenuous.

Seasonal Nesting Patterns

The seasonal pattern of loggerhead nesting in Broward County (Fig. 4) again conformed to the historical norm, showing a relatively symmetrical bell-shaped curve with the first nest in mid April, the last nest in September and the midpoint of the season in Mid June, however the nest on 10 September was unusual. Seasonal nesting at the individual beaches (Fig. 5) was similar to historical expectations, except that the Hillsboro Beach nesting pattern was slightly assymetrical. As in 2001 (Burney and Ouellette, 2001), loggerhead nesting per kilometer was highest at Pompano Beach and Hillsboro Beach, significantly lower in Fort Lauderdale and Lloyd Park, and lowest of all in Hollywood.

The seasonal pattern of green turtle nesting in 2002 (Fig. 6) was very similar to 2000, the last heavily nested year (Burney and Margolis, 2000) with nesting beginning in late May and ending in September. Nesting as late as 26 September has not been previously reported because nesting surveys traditionally ended on 15 September, until they were extended to

30 September last year. Leatherbacks again nested earlier in the season beginning on 2 March (two nests) and ending in early June.

As in previous years, green turtles nested most heavily at Hillsboro Beach and Lloyd Park, possibly due to the reduced beachfront lighting and nocternal human activity on these beaches. Their nesting densities (Fig. 2; Table 7) were highest in Hillsboro Beach, significantly lower in Lloyd Park and significantly lower still in Fort Lauderdale, Pompano Beach and Hollywood, which were statsitically indestinguisable. This order was similar to last year (except Lloyd Park was more densly nested than Hillsboro Beach) and was identical to the pattern in 2000 (Burney and Margolis, 2000; Burney and Ouellette, 2001). Leatherback nesting densities were highest in Hillsboro and lowest in Lloyd Park and Hollywood, but the number of nests was not sufficient to establish any significant countywide differences.

County-wide Nest Distribution

The distribution of loggerhead nests in the 128 survey zones (Figure 9) continues to highlight shoreline features identifiable since 1981. As in past surveys, beaches near piers, inlets, the Fort Lauderdale strip and throughout Dania, Hollywood and Hallandale remained lightly nested. This pattern has been discussed previously (Burney and Mattison, 1992; Mattison et al., 1993). Analysis of the possible factors influencing nesting densities on Broward County beaches in 1999 indicated that measurements of beach front light intensity combined with an index of the ease of public beach access accounted for 36.5 percent of the variance ($P << .001$) in the nesting density pattern for zones R-1 through R-84. Beach width, offshore slope and onshore beach slope were not significant in the stepwise multiple regression (Mattison, 2002).

The number of green turtle nests has never been large enough to establish such a detailed horizontal nesting pattern (Fig. 8), except for their apparent preference for darker beaches with less nocturnal disturbance. The same is true for leatherbacks.

Nesting Success

Overall loggerhead nesting success (Fig. 9, Table 4) decreased slightly from 50.1 percent in 2001 to 47.2 percent in 2002. Nesting success was significantly highest in Fort Lauderdale and Pompano Beach, lowest in Lloyd Park and Intermediate in Hillsboro Beach and Hollywood. Hillsboro Beach experienced the largest one-year drop in nesting success from 56.7 percent in 2001 to 44.9 percent this year. This may reflect the increasing beach erosion in this area. Individual zones with unusually low nesting successes were R-74 and 75 on the Fort Lauderdale strip, R-98 at the Dania Beach pier, R-114 and 115 on the Hollywood broadwalk. All these areas experience heavy nocturnal human activity. Zones R-122 and 123 near the Diplomat resort had low nesting success because there was very little suitable nesting habitat after a small beach nourishment project essentially washed away before nesting season. Nesting success on Hollywood beach was erratic, due to the very low numbers of nests and false crawls in some of the zones.

The overall green turtle nesting success of 38.6 percent (Table 4) increased from 34.7 percent last year and there was no statistical differences county wide. Leatherback nesting success declined from 84.8 percent last year to 75 percent in 2002, but this year's figure was based on only 17 nests and 6 false crawls.

Hatching Success

As in 2001, there was a highly significant difference in the success of *in situ* and relocated nests (Table 6, Fig. 13). The difference was caused by a moderate drop in the success of relocated nests, coupled with a slight increase for *in situ* nests. Hatching successes of both *in situ* and relocated loggerhead nests showed the usual seasonal declines (Fig. 10) but unlike last year, the the slope of the trend line was significantly steeper for relocated nests. The hatching success of in situ and relocated green turtle nests showed the same downward seasonal trends but the slopes of the trend lines were not significantly different. The hatching success distributions for in situ and relocated loggerheads (Fig. 12) showed the same characteristics found last year, with a large statistical difference in the medians. *In situ* nests had much higher frequencies of nests with 80 percent or higher hatching success rates. Relocated nests had higher frequencies in the intermediate percentages. The difference in the hatching success of in situ and relocated nests was not caused by high frequencies of low hatching nests (20 percent or less) in relocated nests, but to a lower frequency of nests hatching at 75 percent or more. The absence of high frequencies of low hatching relocated nests suggests that the lower overall hatching success of these nest was not due to catastrophic nest failures caused by careless handling of the eggs or improper technique.

Figure 14 compares the seasonal hatching success patterns for in situ nests at Hillsboro Beach with those for nests at the two major relocation sites, BH3 and BH900s. Due to severe beach erosion at the traditional open beach hatchery at the Hillsboro Club, a relatively small number of nests were placed at the north and south ends of the Club property (BH1 and BH2, respectively) but many more were carried farther north and relocated along the beach near homes with numbers in the 900s

(BH900s). Because the BH900s area was also too small, another more northerly site (BH3) was established in zone R-9, in an area which had been nourished with dredged sand in 1998. Figure 14 shows that the last *in situ* nest was evaluated on Julian day 200 (19 July). After day 200, an additional 81 nests were evaluated at BH900s (until 8 August) and 23 more even later nests were evaluated at BH3. Since hatching success declines over the season, the larger number and proportion of later relocated nests could partially explain the large difference in the hatching success of *in situ* and relocated nests (Table 6, Fig. 13). Figure 14 also shows that use of sites BH3 and BH900s was alternated, with each area receiving nests during three separate periods. Hatching success of nests at BH3 did not seem to show the overall seasonal decline seen in Figure 10, but this decline was seen in nests relocated to BH900s. The success of the early nests during the first use of this area was good, intermediate for nests relocated around Julian day 160, and much poorer for nests moved between Julian dates 185 and 220. Since the 23 late nests at BH3 did not experience a similarly low hatching rate it appears that the steep seasonal decline in the hatching success of the relocated nests was not entirely due to higher late-season incubation temperatures and more frequent overwash from higher autumn tides. It appears that incubation conditions at BH900s deteriorated over the season. Need some kind of speculation here. **********

As in previous years, Table 7 shows that the largest percentages of unemerged hatchlings or unhatched eggs in nests relocated to Hillsboro Beach were pipped-dead and live-in-nest. This includes nests originally deposited at Hillsboro Beach which were individually relocated to locations outside of the designated hatchery sites (BH). Since these nests were

widely separated, the higher proportion of pipped-dead eggs and live-in-nest hatchlings would not be due to hatchery crowding. In addition, the percentages of pipped-dead eggs and unemerged live hatchlings were much lower for the early nests which were relocated to the restraining hatcheries, suggesting that the higher percentages in these categories in nests relocated to Hillsboro Beach were not entirely caused by the relocation process. The numbers of evaluated green and leatherback nests were too low to make meaningful comparisons of the post hatching nest evaluation data (Tables 8 and 9).

Severe beach erosion in Hillsboro Beach (especially at the Hillsboro Club) has greatly reduced the space available for nest relocation and hindered beach patrols. This forced us to transport nests to beach areas farther to the north of our traditional sites. This increased the workload and some of the northern areas may have been less suitable incubation sites that were more susceptible to inundation late in the season. The availability of suitable hatchery sites for the upcoming season is in doubt. Beach lighting restrictions in Pompano Beach may allow more nests to be left *in situ*. This was done to a limited extent this year, but most of the suitable areas came into lighting compliance late in the season. If there is continued (and expanded) compliance next season, a greater number of nests could be left *in situ*, but this alone will not immediately solve the hatchery site problem.

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APPENDIX 1: Summary of sea turtle hot-line calls.

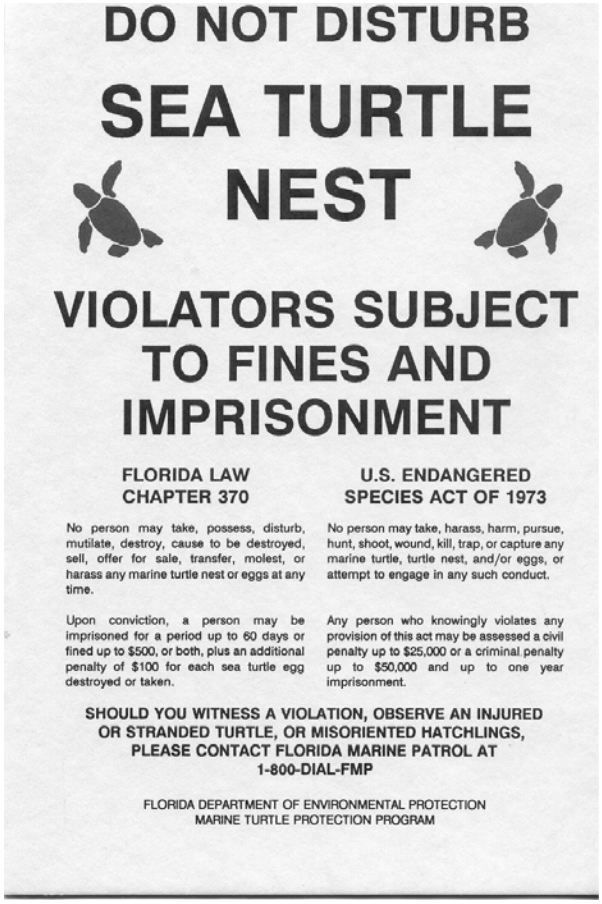
SUBJECT	HOT-LINE
ATV ACCIDENTS	1
LIVE STRANDINGS	3
DISORIENTATIONS	15
NEST LOCATIONS	80
POACHING	2
OTHER	>300
OVERALL	> 400

APPENDIX 2: Summary of Educational/Public Information Activities

Flyers were distributed along the beach, primarily to people who approached workers with questions and at the turtle talks, which usually attracted crowds. Flyers were also distributed to people touring the Oceanographic Center or requesting information by phone or mail.

Public education talks were conducted on Wednesday and Friday evenings from July 18 to Sept. 14 at the Anne Kolb Nature Center. These slide show presentations were followed by hatchling releases near Greene St. in Hollywood. Turtle talks were also given at the Hillsboro Club, an environmental camp and a summer school program.

Appendix 3: Sea turtle nest warning sign. Black lettering on yellow background. Actual size is 5.5" X 8.5".



Appendix 4: Sea Turtle Summary Report Forms